

Occult Carotid Artery Injury Related to Automobile Seat Belts

*A 24-year-old woman had a clinically occult injury of the carotid artery from the shoulder seat belt restraint in a motor vehicle accident. Acute thromboembolism and hemiplegia occurred two hours after her admission to the emergency department. There were contusions of the neck and chest (seat belt sign) but no associated injuries of the cervical spine, mandible, larynx, or brachial plexus. The diagnosis was made by carotid arteriography after the occurrence of thromboembolism. Early clinical suspicion, diagnosis, and surgical repair of the artery are necessary to prevent delayed or recurrent thromboembolism and stroke. Carotid artery and duodenal injuries in this patient were related to improperly fitting seat belts. The current useful preventive measures are adjustment of seat belts to individual body habitus and the regular use of snugly adjusted belts. [Ernst A, Robertson HJ, Bercier ML, Kline DG: Occult carotid artery injury related to automobile seat belts. *Ann Emerg Med* October 1988;17:1091-1094.]*

INTRODUCTION

Motor vehicle seat belt restraints have been shown to significantly reduce morbidity and mortality in accidents.¹ Injuries can, however, occur from the restraints, often when the belts have been improperly adjusted. The seat belt syndrome consists of a variety of injuries attributable to seat belt trauma.²

We present the case of a woman who sustained a seat belt-related, clinically occult injury of a carotid artery with delayed thromboembolism and stroke. In addition, there was rupture of the duodenum by the lap belt.

CASE REPORT

A 24-year-old woman was a front-seat passenger in an automobile involved in an urban intersection head-on vehicle collision. She was wearing a three-point fixed lap and diagonal shoulder belt safety harness at the time of the accident, but it was uncertain if the belts were snugly adjusted. Emergency medical personnel found her to be hypotensive with blood pressure unobtainable and faintly palpable carotid artery pulses at the accident site. Military antishock trousers were applied and on admission to the emergency department systolic blood pressure was 140 mm Hg and pulse was 140. The patient was confused, combative, and moving her extremities except the left leg, with no apparent neurologic deficit. Radiographs of the left leg and foot showed posterior dislocation of the left femur at the hip joint and fracture-dislocation of the left talus bone. There was a 12-cm laceration beneath the mandible on the left side of the neck with palpable skin crepitation down to the level of the clavicles. Small contusions were observed on the right side of the neck and over the sternum. The abdomen was soft and nontender to palpation. The airway was clear and respirations were regular. IV lines were placed in both arms for rapid infusion of fluids.

Two hours after admission the patient had abrupt onset of left hemiparesis, with right gaze preference. Cerebral embolism was suspected as the probable cause. Irregular breathing required placement of a nasotracheal airway. The abdomen was now rigid on palpation. There was blood in the nasogastric tube aspirate and on rectal examination. Diagnostic tap revealed free intraperitoneal blood. No rib or spinal fracture was noted on preliminary radiographs of the chest and cervical spine. Transfusion of two units of packed red blood cells was begun and computed tomography of head, neck,

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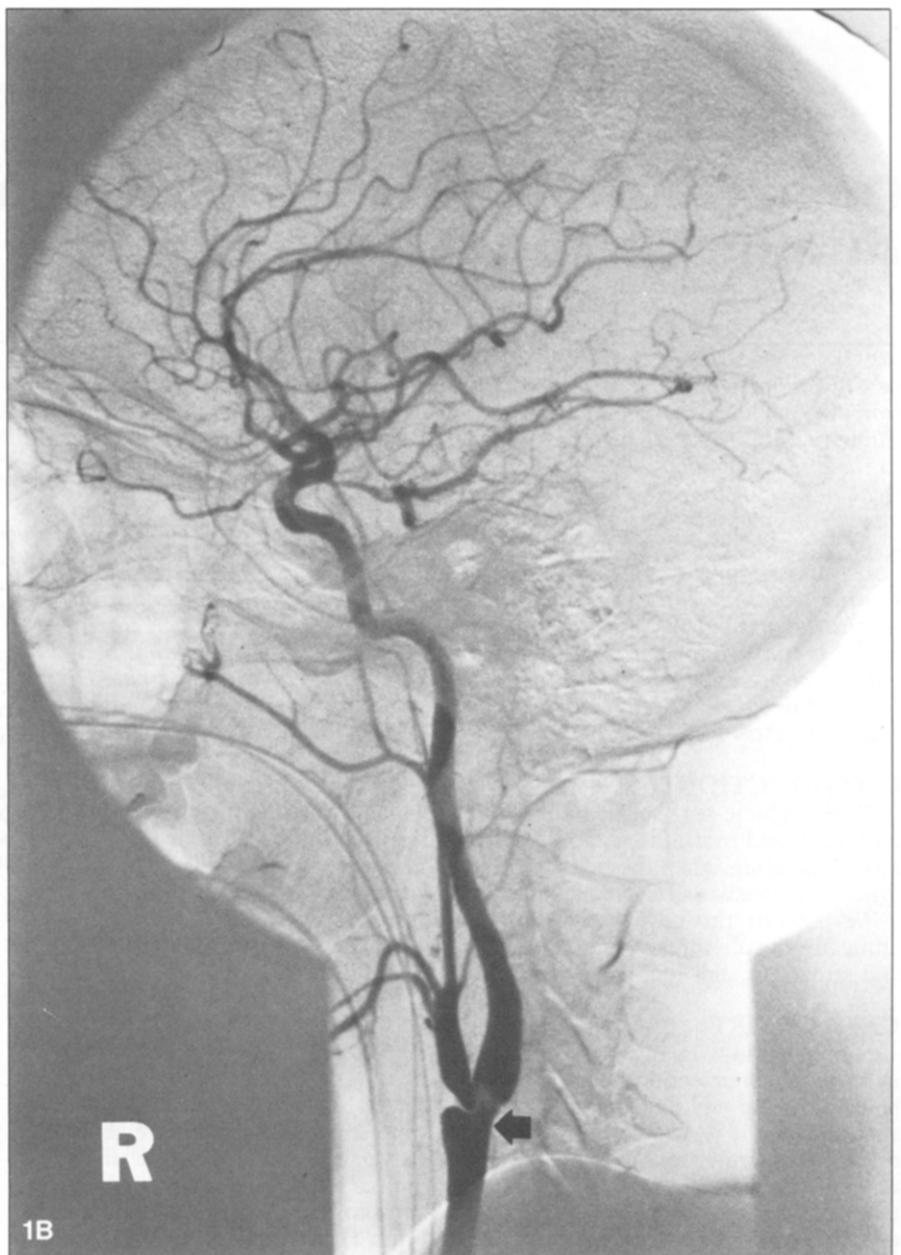
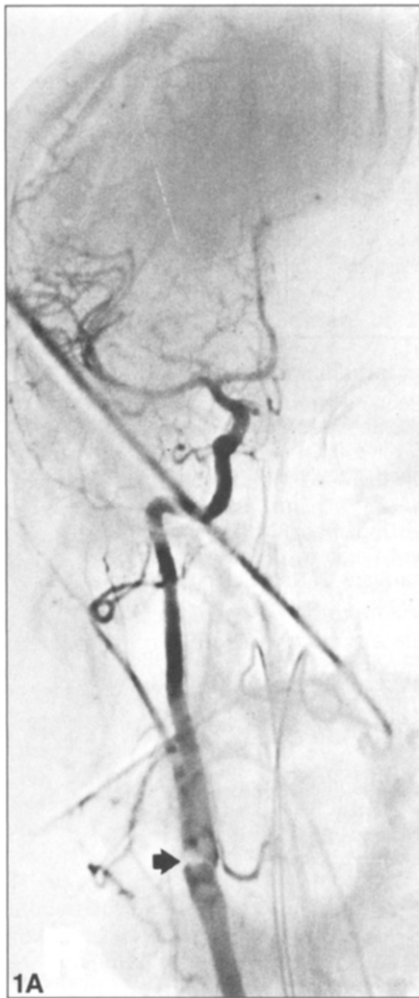


FIGURE 1. (A) Anteroposterior and (B) lateral views of right common carotid arteriogram showing stenosis of bifurcation of common carotid artery and origins of internal and external carotid arteries by intimal dissected flap and thrombus (arrows).

and pelvis was done. The head and neck scans were normal except for subcutaneous and retropharyngeal emphysema in the neck. A "blow-out laceration" of the second portion of the duodenum was the only intra-abdominal injury found at emergency laparotomy. After repair of the duodenal injury, the left hip dislocation was reduced and distal femoral traction was applied. The compound left talus fracture-dislocation was debrided and reduced and a cast was applied.

After surgery, right common carotid arteriography by percutaneous femoral artery catheterization showed narrowing of the lumen at the bifurcation of

the right common carotid artery extending into the origins of the internal and external carotid arteries consistent with dissected intimal flap with thrombus (Figure 1). Immediate carotid artery exploratory surgery was done to repair the injury and to prevent further embolic episodes or internal carotid artery occlusion. The lacerated and dissected intima was repaired, the thrombus was removed, and saphenous vein patch angioplasty was done. Computed tomography brain scan four days after surgery showed right parietal and temporal lobe edema with focal hemorrhage most consistent

with embolic infarction (Figure 2).

Convalescence was complicated by mild pancreatitis. The left hemiparesis showed progressive improvement. Three months after the accident, moderate weakness remained in the patient's left arm and hand, and there was some dysarthria.

DISCUSSION

The Cornell study published in 1960 showed a 60% decrease in injury and a 35% reduction in major or fatal trauma by the use of the lap seat belt.¹ The combined lap and shoulder belt restraints have further reduced the ex-

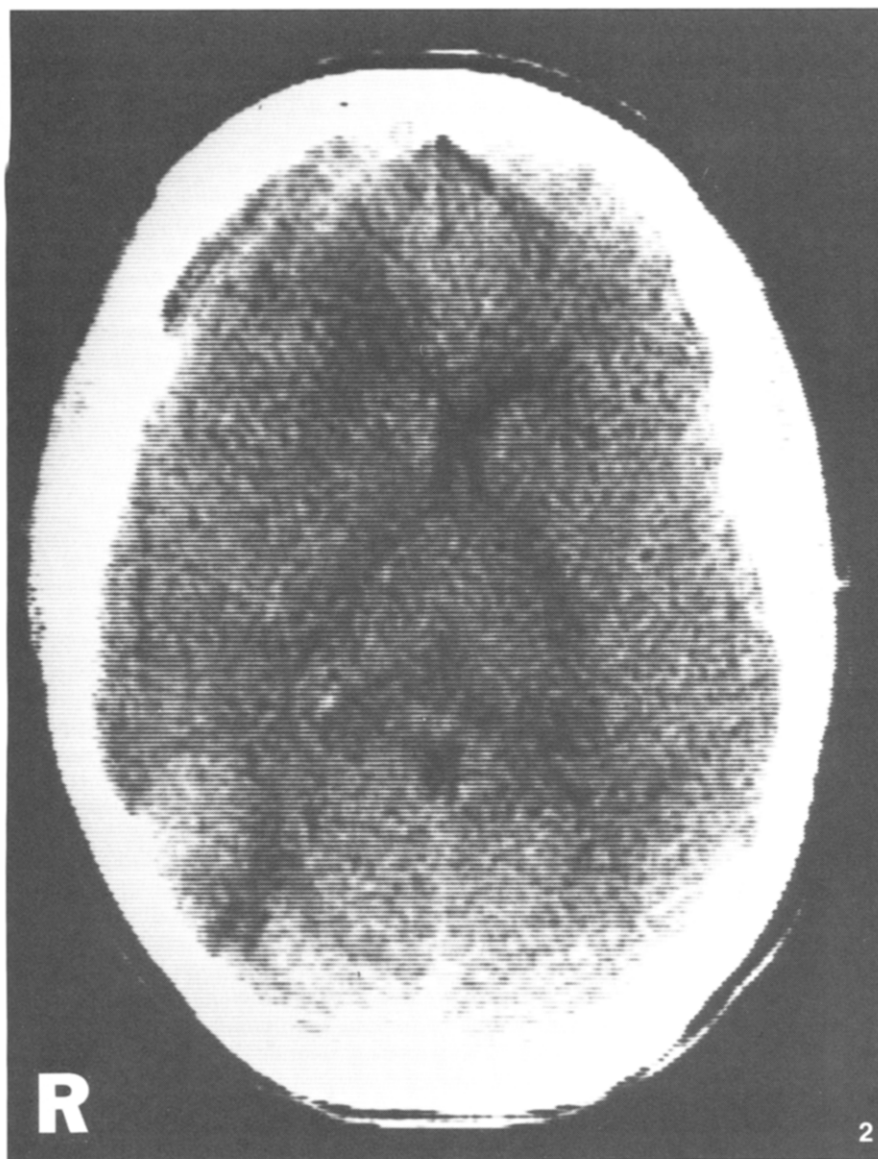


FIGURE 2. Axial computed tomography scan before IV contrast injection showing right frontal, temporal, and parietal decreased attenuation from edema and posterior parietal increased density likely from focal hemorrhage.

Injuries are more frequent with improperly adjusted seat belts.^{3,6,7} Both lap and shoulder belts should be snug. The lap belt should be centered just below the anterior superior iliac spines, and the shoulder belt should be centered over the sternum. Standard fixation points for motor vehicle safety belts make it difficult to properly fit persons of varying body habitus. The diagonal shoulder belt may press excessively on the neck of a short-statured person. Seat belt failure from coincidental broken belt, buckle, or anchor point is rare.^{2,3}

Injuries of virtually all viscera and skeletal structures have been reported from seat belt trauma.³ Abrasions and contusions of the neck, chest, or abdomen attributed to the seat belt constitute the "seat belt sign."⁸

There may be associated injuries of the cervical spine, mandible, larynx, or brachial plexus,⁹ alone or in combination. Rib and sternal fractures are common injuries from the shoulder harness. Documented carotid or vertebral artery injuries related to seat belts are rare.¹⁰⁻¹³ Arterial blunt traumatic intimal tear may result in subintimal hematoma, dissection, pseudoaneurysm, or thrombotic occlusion. Distal arterial branch occlusions can result from dissecting aneurysm, thrombus propagation, or thromboembolism. Arterial transection and arteriovenous fistula are more severe injuries.¹⁴ Clarke and Whittaker¹³ reported coincident traumatic aneurysm of the internal carotid artery with cerebral embolism and stroke and rupture of the duodenum from seat belt injury. The carotid injury was thought to be caused by compression of the artery against the spine by the shoulder belt. Embolism from thrombus formed at the site of arterial injury may be immediate, delayed for hours to years, or recurrent.¹³

Duodenal rupture has been reported more frequently with the use of the lap seat belt than with the use of the combined lap and shoulder belts. Rupture may be the result of direct belt trauma with compression of the duodenum against the spine or from

tent of injury in motor vehicle accidents.³ Death is four times more likely in such accidents without seat belt restraints.⁴ A comparison study one year after the introduction of mandatory legislation for use of seat belts showed a 54% reduction in serious injuries and deaths.⁵

Varied and complex force vectors occur in motor vehicle accidents. Seat belts have been effective in limiting injuries by restraining the torso during the period of rapid deceleration and preventing further injury by secondary collision with parts of the interior of the vehicle or ejection from the vehicle. Collision from the side, with intrusion into the occupant space in the vehicle, may have additional torsional

and direct trauma effects on the restrained torso. Secondary injuries may occur from forward trunk motion and compression against the safety restraints.^{3,6} The lap seat belt alone allows forward flexion of the spine with subsequent head, neck, and chest injuries resulting from contact with the dash, steering wheel, and windshield. Specific injuries of the abdominal viscera and lumbar spine occur. The three- or four-point fixed combined lap and diagonal shoulder safety belts provide more trunk restraint but permit acute flexion of the neck. Headrests attached to the seats are useful in controlling extension of the head and neck during collisions from the rear.

bursting of a functional closed segment of bowel at the moment of impact.^{6,8}

Our patient had contusions of the neck and chest (seat belt sign) but apparently palpable carotid artery pulses at the accident site. The delay of acute onset of hemiparesis suggested carotid artery injury, confirmed by arteriography. The traumatic dissection of the right common carotid artery on the side of the shoulder belt plus the seat belt contusion sign of the neck and anterior chest wall and rupture of the duodenum indicated that the trunk slid under improperly adjusted restraint belts at the time of impact. Thus, the seat belts contributed to major injuries in this patient but may have prevented additional injuries. This is the second known reported case of combined carotid artery injury with delayed thromboembolism and duodenal rupture from seat belt injury.¹³

Preliminary noninvasive ultrasound diagnostic study of the carotid arteries in the neck may be helpful in those patients with some possibility of carotid artery injury. Carefully performed duplex ultrasound study with high resolution Doppler and compound B scans may detect carotid artery dissection, intimal flap, thrombus, associated atherosclerosis, aneurysm, or arteriovenous fistula. Doppler color flow studies are most sensitive for carotid artery injury.¹⁵ Carotid arteriography remains the most specific diagnostic study for arterial trauma and will usually be necessary before surgical repair of the carotid artery in the neck.

The US automobile manufacturers, in compliance with a request by the US Department of Transportation, began to install optional automatic restraints in the front seats of new cars in 1987.¹⁶ These restraints include

seat belts that fasten automatically as the vehicle door is closed and airbags that inflate automatically with sufficient impact force. It has been suggested that all new US cars may have these devices as standard equipment by 1990.¹⁶ It is difficult to envision automatic seat belts being snugly adjusted and comfortable for all occupants because the current manually fastened seat belts in US cars often cannot be properly adjusted to each occupant's size and shape.

A recent study done for the Insurance Institute for Highway Safety indicated that 35% of automobile drivers who use seat belts have some slack in the shoulder belts and are thus liable to have injury from protruding objects within the car or secondary injury from the belt.^{17,18} Laboratory and field studies indicate that airbag restraints will likely reduce significantly the extent and severity of injuries in motor vehicle accidents.¹⁹

SUMMARY

Unsuspected carotid artery injury can occur as a result of blunt trauma to the neck from the seat belt shoulder harness. The case of a woman with carotid artery injury diagnosed after the onset of hemiparesis, with associated duodenal rupture, is presented. Early diagnosis of occult carotid artery injury by selective carotid arteriography and urgent surgical arterial repair is necessary to prevent delayed or recurrent thromboembolism and stroke.

REFERENCES

1. Tourin B, Garrett JW: *Safety Belt Effectiveness in Rural California Automobile Accidents. Automobile Crash Injury Research*. Ithaca, New York, Cornell University, 1960.
2. Garrett JW, Braunstein PW: The seat belt syndrome. *J Trauma* 1962;2:220-238.
3. Sims JK, Ebisu RJ, Wong RKM, et al: Auto-

mobile accident occupant injuries. *JACEP* 1976;5:796-808.

4. Seat belts: The overwhelming evidence (editorial). *Br Med J* 1977;6061:593-594.

5. Christian MS: Morbidity and mortality of car occupants: Comparative survey over 24 months. *Br Med J* 1984;289:1525-1526.

6. Williams JS, Kirkpatrick JR: The nature of seat belt injuries. *J Trauma* 1971;11:207-218.

7. Gogler H, Athanasiadis S: Fatal cervical dislocation related to wearing a seat belt: A case report. *Injury* 1979;10:196-200.

8. Hudson I, Kavanagh TG: Duodenal transection and vertebral injury occurring in combination in a patient wearing a seat belt. *Injury* 1983;15:6-9.

9. Sturm JT, Perry JF Jr: Brachial plexus injuries from blunt trauma — A harbinger of vascular and thoracic injury. *Ann Emerg Med* 1987; 16:404-406.

10. Mattes W, Dorstelmann D, Cramer G: Stumpfes Halsstrauma durch sicherheitsgurt stenosisierung der a carotis interna und a vertebralis. *Dtsch Med Wochenschr* 1983;108: 22-25.

11. Mohsenipour I, Benedetto KP, Twerdy K: Traumatischer carotisverschluss durch sicherheitsgurte. *Unfallheilkunde* 1981;84: 278-281.

12. Hoang TDE, Pourriot JL, Lapandry C, et al: Dissection de la carotide interne. *Ann Fr Anesth Reanim* 1984;3:388-391.

13. Clarke P, Whittaker M: Traumatic aneurysm of the internal carotid artery and rupture of the duodenum following seat belt injury. *Injury* 1980;12:158-160.

14. Schellhas KP, Latchaw RE, Wendling LR, et al: Vertebrobasilar injuries following cervical manipulation. *JAMA* 1980;244:1450-1453.

15. Merritt CRB: Doppler color flow imaging. *J Clin Ultrasound* 1988;15:591-597.

16. Automatic belts or cushions: Consumers have limited choices (editorial). *AAA World* 1987;7:2.

17. Ciccone M, Wells J: Improper shoulder belt use by Maryland drivers. Washington, DC, Insurance Institute for Highway Safety, 1987.

18. Slavik DH: Defective seat belts. *Trial* 1988;24:34-38.

19. Williams AF, Lund AK: Seat belt use laws and occupant crash protection in the United States. *Am J Public Health* 1986;76:1438-1442.